# Timothy L. Crawford, Ph.D.

447 Springwood Ln
Idaho Falls, ID, 83404
(208) 524-2303 Tim.Crawford@noaa.gov

## OBJECTIVE

I seek a challenging position in which my engineering education and work experience can be used with my creative nature to efficiently manage and accomplish technical projects related to the theory, measurement and modeling of environmental problems.

## EMPLOYMENT

### NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION 1986-Present

**Director, Field Research Division** **1998-Present**
NOAA Air Resources Laboratory Idaho Falls, ID

I lead fourteen scientist in theoretical and experimental investigations into atmospheric transport and diffusion, and plan for nuclear emergency preparedness and response. We develop and validate innovative models describing atmospheric transport, dispersion and air-surface exchange. Our field research requires that we develop and apply tracer release along with airborne and stationary sampling systems. These systems use technologically complex computer, chemical and differential global positioning systems. Typically, each year we complete of four to eight research experiments. (See http://www.noaa.inel.gov)

**Chief, Air Surface Exchange Branch** **1992-1998**
NOAA AIR RESOURCES LABORATORY OAK RIDGE, TN

Since creation in 1992, I expanded the branch to twelve scientists and engineers, whom I lead in theoretical and experimental research investigations. We develop and validate innovative models describing atmospheric transport and air-surface exchange. Field research requires that we develop and apply airborne and stationary sampling systems. My administrative duties include developing, funding, and planning research programs and also supervising staff, and handling personnel actions. I have developed branch involvement or principal investigator interest in DOE, NOAA, NASA, NSF, EPA, ONR and OSU research programs.

**Physical Scientist** **1988-92**
NOAA AIR RESOURCES LABORATORY OAK RIDGE, TN

Originally, my duties included model development to simulate material transport, diffusion and deposition. I expanded this scope to include physical experiments. I developed a "generic" mobile flux technology and incorporated its use in research and model validation experiments. I have proven this mobile flux technology on my Long-EZ airplane, a NOAA Twin Otter and several boats. This technology has demonstrated the fidelity to allow $CO_2$ flux measurement over oceans and tundra. As a result it has rapidly gained acceptance for application to both terrestrial and ocean ecosystems and has led to participation in many research efforts.

**Physical Scientist** **1986-88**
NOAA FIELD RESEARCH DIVISION IDAHO FALLS, ID

I planned and directed sampling for NOAA's Across North America Tracer Experiment. This included the development of SOP's for five sampling systems; the contact, training and direction of 200 US, Canadian and European instrument operators; the shipping, receiving and quality control of 13,000 samples; and the development of data archive procedures. I also developed and obtained funding for the validation of a remote sensing chemical agent instrument.

## TENNESSEE VALLEY AUTHORITY 1972-86

**Supervisor, Atmospheric Physics Unit** **1979-86**
TVA AIR QUALITY BRANCH MUSCLE SHOALS, AL

After creating the Unit, I expand staff to six professionals and three technicians. Duties included planning, writing proposals, budget control, staff supervision, and personnel actions. The Unit completed pioneering field investigations and developed models to understand and describe long range transport, visibility impairment, and acid rain. Previous responsibilities for assessing near field transport and diffusion continued. Direct field research involvement included experimental design, field planning, along with instrument selection, installation and operation. I lead all data collection, processing, analysis and publication efforts. The unit developed an acid rain assessment model; a 3D dynamic trajectory model; and established a high elevation forest decline research station for EPA's Mountain Cloud Chemistry Program.

**Research Analyst** **1978-79**
TVA AIR QUALITY BRANCH MUSCLE SHOALS, AL

I supervised two professionals and one technician in theoretical and experimental investigations of long-range air pollutant transport. This required the development and use of airborne sampling systems. Significant ground measurements, including tetroon deployment and tracking, supported the airborne measurements. Responsibilities included data interpretation and reporting. Previous responsibility for development, modification, and testing of atmospheric diffusion models, and supervision of physical modeling contracts continued.

**Environmental Engineer** **1975-78**
TVA AIR QUALITY BRANCH MUSCLE SHOALS, AL

Duties included providing the theoretical basis for atmospheric diffusion assessments of emissions from power plants, cooling towers and fertilizer facilities; developing and monitoring contracts for wind-tunnel dispersion modeling; coordinating the conduct of related projects among participating groups within or outside TVA; and, supervising the collection, reduction, display and interpretation of data obtained during Intermittent Control System (ICS) validation studies. Also, I developed ICS for three TVA power plants.

**Environmental Engineer** **1972-75**
TVA AIR QUALITY BRANCH MUSCLE SHOALS, AL

Duties included assisting with the planning, organizing and supervising of field studies. All data archives and initial data reduction were my responsibility. I developed ICS's for four power plants. Diffusion models were run and reports prepared assessing the ambient particulate concentrations near all TVA power plants. I also did environmental assessment for various chemical plant emissions.

---

## EDUCATION

**Doctor of Philosophy** **1977**
UNIVERSITY OF WATERLOO WATERLOO, ONTARIO
Major: Mechanical Engineering -- Geophysical Fluid Dynamics.
Thesis: "Numerical modeling of complex two and three-dimensional flow and diffusion problems in the natural air environment," I worked my way through school as a consultant to the Canadian Atmospheric Environment Service and local utilities in developing control strategies.

**Master of Science** **1972**
UNIVERSITY OF ILLINOIS CHAMPAIGN, IL
Major: Civil Engineering -- Air Resources (GPA 4.93/5)

**Bachelor of Science** -- High Honors **1971**
UNIVERSITY OF ILLINOIS CHAMPAIGN, IL
Major: Mechanical Engineering --Thermal sciences (GPA 4.75/5)

**Junior Electrical Engineer** **Summers -- 1969-70**
DICKY-JOHN CORP. SPRINGFIELD, IL

**CONTINUING EDUCATION**
Many seminars, short courses, management courses and workshops

## SKILLS

*Aviation:*
- Commercial Instrument pilot
- 3000 flight hours
- Technical advisor, Exp Aircraft Association
- FAA A&P and aircraft builder
- Built 3 single and 2 twin-engine aircraft
- Own, maintain, and operate two aircraft
- 2nd Class medical certificate
- Instructed gas, arc, and TIG welding

*Computers:*
- Languages - Fortran, APL, BASIC, C, C++
- Systems - IBM, VAX, PC's (DOS & OS2)
- Applications - WordPerfect, QuattroPro, MatLab, & many others

*Electronics:*
- Read/understand electrical schematics
- Built many scientific instruments
- Proficient with linear circuits
- Good knowledge of digital circuits
- Built many computers/data systems

## ACTIVITIES

- American Meteorological Society
- Experimental Aircraft Association
- National Management Association
- Aircraft Owners and Pilots Association
- Electric Power Research Institute Advisor
- Mountain Cloud Chemistry Site Director
- American Geophysical Union
- PI -- BOREAS, LAII, TOGA/COARE, etc.
- Southern Appalachian Research Resource Management Counsel

## RECOGNITION

- NOAA Administrator's Award for Twin Otter Instrumentation, Nov 95
- Twelve DoC certificates of recognition for superior job performance
- Pi Tau Sigma Honorary Mechanical Engineering Fraternity
- Official recognition for 25 years of federal service
- Advisor- National Research Council
- Government clearance -- Secret
- Media article --"Flying in the Face of Science," *Destination Discovery*, Feb 95
- TV --"Planes for Global Warming" Discovery TV, Oct 11, 96
- LONG-EZ with a purpose, *Sport Aviation*, July 1999
- DOC Bronze Medal Award for design & application of a novel airborne instrument system

## REFERENCES

Dr. Richard S. Artz, Deputy Director, NOAA/Air Resources Laboratory, 1315 East West Highway, 3212 SSMC3, Silver Spring, MD 20910 (301) 713-0972, Richard.Artz@noaa.gov

Dr. Jorg M. Hacker, Director Airborne Research Australia, Flinders University, GPO Box 2100, Adelaide 5001, Australia +61-8-81824000, jhacker@es.flinders.edu.au

Bruce B. Hicks, Director NOAA/Air Resources Laboratory, 1315 East West Highway, 3152 SSMC3, Silver Spring, MD 20910 (301) 427-7684, Bruce.Hicks@noaa.gov

Dr. Ray P. Hosker, Director NOAA/Atmospheric Turbulence and Diffusion Division, P.O. Box 2456, Oak Ridge, TN 37831. (865) 576-1248, hosker@atdd.noaa.gov

## PERSONAL

Born: 1948, Married, two daughters, excellent health. Social Security number -- 359-40-3998

**MANAGEMENT TRAINING**

Timothy L. Crawford

| EDUCATIONAL ACTIVITY | SPONSOR | DATE | HOURS |
|---|---|---|---|
| CAMS Training for Managers | NOAA/MASC | 7/02 | 8 |
| Personal Property Management | NOAA/MASC | 3/99 | 16 |
| Safety Training for Managers | NOAA/MASC | 5/99 | 12 |
| Managing Multiple Projects & Objectives | DoC/Skilpath Seminars | 6/98 | 8 |
| DoC/Automated Classification System | DoC | 8/97 | 8 |
| Supervisory Training | DOC/EASC | 5/93 | 16 |
| EEO in the Federal Government | OPM | 3/93 | 16 |
| Planning and Organizing | TVA | 5/85 | 8 |
| First Aid Training | Read Cross | 12/84 | 16 |
| Managing Interpersonal Relationships | Willson Learing Center | 9/84 | 16 |
| Health& Safety Training for Supervisors | TVA | 9/83 | 8 |
| Defensive Driving | National Safety Council | 5/83 | 6 |
| Managing Time | TVA | 5/83 | 8 |
| Conflict Management | TVA | 12/82 | 16 |
| Managing Performance | TVA | 12/82 | 12 |
| Project Management Training | Univ of Tennessee | 2/81 | 24 |
| Leadership Skills for Managers | TVA | 9/78 | 14 |
| Report Writing Workshop | Univ of Tennessee | 8/77 | 25 |
| Accelerated Reading | Univ of Tennessee | 11/72 | 20 |
| Numerous Lunch Hour National Management Association Films | NMA | --- | --- |

## PUBLICATIONS

### by Timothy L. Crawford

### In Progress

Mahrt, L, D. Vickers, T. Crawford, W. Drennan and H. Graber. Flux Measurements from moving platforms, In final draft

Crawford, T. L. and R. J. Dobosy, Revised and accepted: Accuracy and Utility of Aircraft Flux Measurements. *Biospheric Feedbacks in the Climate System and the Hydrological Cycle*, Editors: J H C Gash and P Kabat, Springer-Verlag Berlin Heidelberg New York

Crawford, T. L., G. H. Crescenti, and J. Hacker, In Draft: Small Environmental Research Aircraft (SERA): The Future of Airborne Geoscience, BAMS

Crawford, T. L., and R. J. Dobosy, In Progress: Aircraft attitude, velocity and position measurement with application to wind measurements

### Journal Articles

Sun, J., D. Vandemark, L. Mahrt, D. Vickers, T. L. Crawford, and C. Vogel, 2001: Momentum transfer over the coastal zone[1], *J of Geophysical Research-Atmosphere,* **106:** 12437-12,448

Mahrt, L., D. Vickers, J. Sun, T. Crawford, G. H. Crescenti, and Frederickson, 2001: Surface stress in offshore flow and quasi-frictional decoupling.0 J of Geophysical Research, **160:** 20,629-20,639

Vickers, D., L. Mahrt, J. Sun, and T. Crawford, 2001: Structure of Offshore Flow, *M Weather Review*, **129:** 1251-1258

Vandemark, D., P. D. Mourad, S. A. Bailey, T. L. Crawford, C. A. Vogel, J. Sun, and B. Chapron, 2001: Measured changes in ocean surface roughness due to atmospheric boundary layer rolls, *J of Geophysical Research,* **106:** 4639-4654.

Oechel, W. C., G. L. Vourlitis, J. Verfaillie, Jr., T. Crawford, S. Brooks, E. Dumas, A. Hope, D. Stow, B. Boynton, V. Nosov, and R. Zulueta, 2000: A scaling approach for quantifying the net CO2 flux of the Kuparuk River Basin, Alaska. *Global Change Biology*, **6**, 160-173.

Vogel, C. A., and T. L. Crawford, 1999: Exchange measurements above the air-sea interface using an aircraft[1]. *Air-Sea Exchange: Physics, Chemistry and Dynamics*, G. L. Geernaert, Ed., Kluwer Academic Publishers, 231-245.

Hacker, J. M. and T. L. Crawford, 1999 The BAT-probe: The ultimate tool to measure turbulence from any kind of aircraft (or sailplane), *J of Technical Soaring*, **XXIII**:2, 43-46

Oechel W. C., G. L. Vourlitis, S. B. Brooks, T. L. Crawford and E. J. Dumas 1998. Intercomparison between chamber, tower, and aircraft net CO2 exchange and energy fluxes measured during the Arctic system sciences land-atmospher-ice interaction (ARCSS-LAII) flux study. *J of Geophysical Research* 103: 28993-29003

Crawford, T. L., and R. J. Dobosy, 1997,Pieces to a puzzle[1]: Air-surface exchange and climate, *GPS World,* **8**(11), 32 - 39

Sun, J., D. H. Lenschow, L. Mahrt, T. L. Crawford, K, J. Davis, S. P. Oncley, J. I. MacPherson, Q. Wang, R. J. Dobosy, and R. L. Desjardins, 1997, Lake-induced atmospheric circulations during BOREAS, *J Geophys. Res*. **102:** 29, 29155-29166

Dobosy, R.J., T.L. Crawford, J.I. MacPherson, R.L. Desjardins, R. D. Kelly, S.P. Oncley, and D. H. Lenschow, 1977: Intercomparison among the four flux aircraft at BOREAS in 1994. *J of Geophysical Research*. *J of Geophysical Research*. **102:** 24, 29101-29111

Brooks, S. B., T. L. Crawford, and W. C. Oechel, 1997: Carbon dioxide emissions plumes from Prudhoe Bay, Alaska, oil fields. *J of Atmos Chemistry*.Vol. 27, **2:**197-207

Oechel W. C., S. B. Brooks, T. L. Crawford, E. J. Dumas et al. 1996. CO2 flux fromarctic tundra measured at three scales by chamber, eddy correlation tower, and aircraft techniques: extrapolation to a watershed scale. *Annals of Geophysics* Volume **XX**

Crawford, T. L., R. J. Dobosy, R.T. McMillen, C. A. Vogel, and B. B. Hichs, 1996: Air-surface exchange measurement in heterogeneous regions: Extending tower observations with spatial structure observed from small aircraft. *Global Change Biology* **2**: 275-285.

Crawford, T. L., R. J. Dobosy, and E. Dumas, 1995: Aircraft wind measurement considering lift-induced upwash. *Boundary-Layer Meteorology*. **80:** 79-94

Crawford, T. L., R. T. McMillen, R. J. Dobosy, and I. MacPherson, 1993: Correcting airborne flux measurements for aircraft speed variation. *Boundary-Layer Meteorology* **66**: 237-245.

Crawford, T. L., R. T. McMillen, T. P. Meyers, and B. B. Hicks, 1993: The spatial and temporal variability of heat, mass, and momentum air-sea exchange in a coastal environment. *Journal of Geophysical Research* 98:**12:** 869-12,880.

Doran, J. C., F. J. Barnes, R. L. Coulter, T. L. Crawford, D. D. Baldocchi, L. Balick, D. R. Cook, D. Cooper, R. J. Dobosy, W. A. Dugas, L. Fritschen, R. L. Hart, L. Hipps, J. M. Hubbe, W. Gao, R. Hicks, R. R. Kirkham, K. E. Kunkel, T. J. Martin, T. P. Meyers, W. Porch, J. D. Shannon, W. J. Shaw, E. Swiatek, and C. D. Whiteman, 1992: The Boardman Regional Flux Experiment. *Bulletin of the American Meteorological Society* **73:** 1785-1795.

Crawford, T. L. and R. J. Dobosy, 1992: A sensitive fast-response probe to measure turbulence and heat flux from any airplane. *Boundary-Layer Meteorology* **59:** 257-278.

Reisinger, L. M. and T. L. Crawford, 1982: Interregional transport: case studies of measurements versus model predictions. *Journal of Air Pollution Control Association* **32:** 529-633.

Reisinger, L. M. and T. L. Crawford, 1980: Sulfate flux through the Tennessee Valley region. *Journal of the Air Pollution Control Association* **30:**1230-1231.

Crawford, T. L. and P. R. Slawson, 1979: Modeling near-field behavior of plumes from mechanical draft cooling towers. *Cooling Tower Environment* - 1979, 20 pp.

Coleman, J. H., T. L. Crawford and R. M. Rubendall, 1978: Characterization of cooling-tower plumes from Paradise Steam Plant. *Cooling Tower Environment* - 1978, 22 pp.

Raithby, G. D., W. L. Hallett, T. L. Crawford and P. R. Slawson, 1978: Measurements and predictions of turbulent recirculating flow over a rectangular depression. *Boundary-Layer Meteorology* **15**:181-194.

Crawford, T. L. and W. B. Norris, 1978: Estimating atmospheric dilution of brief, infrequent, random releases. *Atmospheric Environment* **13:** 29-33.

Crawford, T. L., 1977: Numerical modeling of complex two and three-dimensional flow and diffusion problems in the natural environment. Ph.D. Thesis, University of Waterloo, Waterloo, Canada.

Montgomery, T. L., J. M. Leavitt, T. L. Crawford and F. E. Gartrell, 1973: Controlling ambient $SO_2$ *Journal of Metals*, June 1973, 7 pp.

**Formal Reports (peer reviewed)**

Crescenti, G. H., J. R. French, T. L. Crawford, and D. C. Vandemark, 2002: An integrated airborne measurement system for the determination of atmospheric turbulence and ocean surface wave field properties. Preprint, *Sixth Symposium on Integrated Observing Systems*, Orlando, FL, Jan. 13-17, Amer. Meteor. Soc., 60-67.

Crawford, T. L., G. H. Crescenti, and J. M. Hacker, 2001: Small environmental research aircraft: The future of airborne geoscience. Preprint, Eleventh Symposium on Meteorological Observations and Instrumentation, Albuquerque, NM, Amer. Meteor. Soc., 117-122

Crawford, T. L., G. H. Crescenti, and J. M. Hacker, 2001: Small Environmental Research Aircraft (SERA): The future of airborne geoscience. Preprint *Eleventh Symposium on Meteorological Observations and Instrumentation*, Albuquerque, NM, Amer. Meteor. Soc., 117-122.

Dobosy , R. J., Crawford, T. L., D. L. Auble, G. H. Crescenti, and R. C. Johnson, 2001: The extreme turbulence (ET) probe for measuring boundary-layer turbulence during hurricane-force winds. Preprint *Eleventh Symposium on Meteorological Observations and Instrumentation*, Albuquerque, NM, Jan. 14-19, Amer. Meteor. Soc., 50-54.

French, J. R., T. L. Crawford, and R. C. Johnson, 2001: A high-resolution temperature probe for airborne measurements. Preprint *Eleventh Symposium on Meteorological Observations and Instrumentation*, Albuquerque, NM, Jan. 14-19, Amer. Meteor. Soc., 139-144.

Sun, J., D. Vandemark, L. Mahrt, D. Vickers, T. L. Crawford, and C. Vogel, 2000: Momentum transfer over the coastal zone, *14th Symposium on Boundary Layer and Turbulence*, 7-11 August, Snowmass, Colorado.

Cote, O. R., J. M. Hacker, T. L. Crawford, and R. J. Dobosy. 2000. Clear air turbulence and Refractive Turbulence in upper troposphere and lower stratosphere. Proceedings, Aviation Range and Aerospace Meteorology Conference, Sept. 11-15, 2000, Orlando, FL, American Meteorological Society.

French, J. R., G. H. Crescenti, T. L. Crawford, and E. J. Dumas, 2000: Data Report: LongEZ (N3R) participation in the 1999 Shoaling Waves Experiment (SHOWEX). NOAA Technical Memorandum OAR ARL- 20, Silver Spring, MD, 51 pp.

French, J. R., G. H. Crescenti, T. L. Crawford, and E. J. Dumas. 2000: LongEZ (N3R) participation in the 1999 Shoaling Wave Experiment (SHOWEX). NOAA Data Report OAR ARL-20, 51pp.

French, J. R., G. H. Crescenti, T. L. Crawford, E. J. Dumas, and D. Vandemark, 2000: Measurements pertaining to air-sea interaction with a small instrumented aircraft. *Sixth International Conference on Remote Sensing for Marine and Coastal Environ.*, Charleston, SC, May 1-3, pp. Veridian ERIM, II-110-113

Hacker, J. M., B. Neininger, T. L. Crawford, 2000: Airborne monitoring of air quality using cost-efficient small aircraft combined with state-of-the-art sensor systems. *Seventh International Conference on Atmosphere Science and Applications to Air Quality*, Taipei, Taiwan, Oct 31-Nov 2

Vickers, D., L. Mahrt, J. Sun, and T. Crawford, 2000: Momentum flux in off-shore flow. Preprint, *14th Symposium on Boundary Layers and Turbulence*, Aspen, CO, Amer. Meteor. Soc., paper P6A.6.

Crescenti, G.H., and T.L. Crawford,1999: Data report: LongEZ (N3R) participation in the 1999 Shoaling Wave Experiment (SHOWEX) spring pilot study. NOAA Technical Memorandum ERL ARL-232, Silver Spring, MD, 86 pp.

Dobosy, R.J.,T. L. Crawford, D. Vandemark, C.A. Vogel, 1999. Measurement of Ocean Surface in Shoaling Zones by Laser Array and Ka-Band Radar. *Fourth International Airborne Remote Sensing Conference and Exhibition*, ERIM International, 21-24 Jun., Ottawa, Canada

Eckman, R.M., T.L. Crawford, E.J. Dumas and K.R. Birdwell, 1999: Airborne meteorological measurements collected during the Model Validation Program (MVP) field experiments at Cape Canaveral, Florida. NOAA Technical Memorandum ERL ARL-233, 61 pp.

Mahrt, L., D. Vickers, J. Sun, T. Crawford, C. Vogel, and E. Dumas, 1999: Coastal zone boundary layers. Preprint, *13th Symposium on Boundary Layers and Turbulence*, Dallas, TX, Amer. Meteor. Soc., 403-406.

Sun, J., L. Mahrt, D. Vickers, J. Wong, T. Crawford, C. Vogel, E. Dumas, P. Mourad, and D. Vandemark, 1999: Air-sea interaction in the coastal shoaling zone. Preprint, *13th Symposium on Boundary Layers and Turbulence*, Dallas, TX, Amer. Meteor. Soc., 343-345.

Vandemark, D., P. D. Mourad, T. L. Crawford, C. A. Vogel, J. Sun, S. A. Bailey and B. Chapron, Measured changes in ocean surface roughness due to atmospheric boundary layer rolls, Submitted for review to JGR-Oceans, Aug. 1999.

Vandemark, D., T. Crawford, R. Dobosy, T. Elfouhaily and B. Chapron, 1999. Sea surface slope statistics from a low-altitude aircraft. *IEEE Proceedings of International Geoscience and Remote Sensing Symposium (IGARSS)*, Hamburg, 28 June - 2 July.

Vandemark, D., P. Mourad, T. Crawford, C. Vogel, J. Sun, 1999. Measured correlations between roll-vortex signatures and radar-inferred sea surface roughness. *IEEE Proceedings of International Geoscience and Remote Sensing Symposium (IGARSS)*, Hamburg, 28 June - 2 July.

Vogel, C. A., T. L. Crawford, J. Sun, and L. Mahrt, 1999: Spatial variation of the atmospheric surface drag coefficient within a coastal shoaling zone. Preprint, 13th Symposium on Boundary Layer and Turbulence, Dallas, TX, Amer. Meteor. Soc., 347-348.

Dobosy, R.J., T. L. Crawford, J.I. MacPherson, R.L. Desjardins, R. D. Kelly, S.P. Oncley, and D. H. Lenschow. 1997. Intercomparison among the four flux aircraft at BOREAS in 1994. Journal of Geophysical Research, 102, D24, December 1997, 29,101-29,111.

Brooks S. B, T. L. Crawford, R. T. McMillen, and E. J. Dumas: 1996, Airborne measurements of mass, momentum, and energy fluxes, Arctic Landscape Flux Survey (ALFS) - 1994, 1995. NOAA Technical Memorandum ARL/ATDD-216.

Dobosy, R. J. and T. L. Crawford, 1996: Accurate aircraft wind measurements using the Global Positioning system (GPS). In Proc. of the Conference on Airborne Remote Sensing and Exibition, San Francisco, California, 24-27 June 96

Dobosy, R. J. T. L. Crawford, C.A. Vogel, and D. D. Baldocchi, 1996: Judging the area representated by flux measurements from a tower in a heterogeneous region. In Proc. of the 22nd Conf on Agriculturial and Forest Meteorology. 28 Jan- 2Feb, Atlanta GA

Kelly R. D., J. I. MacPherson, Dobosy, R. J. and T. L. Crawford, 1996: BOREAS 1994 intercomparison among three flux aircraft. In Proc. of the 22nd Conf on Agriculturial and Forest Meteorology. 28 Jan- 2Feb, Atlanta GA

Vogel, C. A.,and T. L. Crawford: 1996, Temporal and spatial variabilities of heat, moisture, $CO_2$ and momentum flux densities above the air-sea interface. In 1996 *Ocean Sciences Meeting*, American Geophysical Union, San Diego, CA, 12-16 February 1996.

Vogel, C. A., D. D. Baldocchi, T. L. Crawford, G. den Hartog, P. G. Jarvis, J. M. Massheder, R. T. McMillen, H. H. Neumann, and R. M. Stabler: 1995, A comparison of surface flux measurements from an aircraft and towers during the 1994 BOREAS and 1994 ALFS field campaigns. *Spring Meeting*, American Geophysical Union, Baltimore, MD, 30 May-2 June

Crawford, T. L., R. J. Dobosy and K. R. Birdwell, 1993: Airborne measurements of mass, momentum, and energy fluxes for the Boardman-ARM Regional Flux Experiment - 1991. NOAA Technical Memorandum ERL ARL 202, 174 pp.

Crawford, T. L., J. A. Herwehe, T. P. Meyers, and K. R. Birdwell, 1993: Airborne energy and trace species flux measurements over lake Michigan. NOAA Technical Memorandum ERL ARL 93/7.

Crawford, T. L. and R. T. McMillen, 1991: Direct measurement of $CO_2$ exchange to the ocean using an airborne eddy correlation system. In *Proc. of the 7th Conference on Meteorological Observations and Instrumentation*, New Orleans, LA, American Meteorological Society, Boston, MA, 42-45.

Crawford, T. L. , R. T. McMillen and R. J. Dobosy, 1991: Description of a "generic" mobile platform using a small airplane and a pontoon boat. In *Proc. of the 7th Conference on Meteorological Observations and Instrumentation*, New Orleans, LA, American Meteorological Society, Boston MA, 37-41.

Dobosy, R. J. and T. L. Crawford, 1991: Developments in turbulence measurement by pressure sphere. In *Proc. of the Conference on Meteorological Observations and Instrumentation*, New Orleans, LA, American Meteorological Society, Boston, MA, 151-155.

McMillen, R. T. and T. L. Crawford, 1991: Direct measurement of $CO_2$ exchange to the ocean using a ship-mounted eddy correlation system. In *Proc. of the Conference on Meteorological Observations and Instrumentation*, New Orleans, LA, American Meteorological Society, Boston, MA, 46-50.

Nappo, C. J., T. L. Crawford, R. M. Eckman and D. L. Auble, 1991: A sensitive electronic microbarograph network. In *Proc. of the Conference on Meteorological Observations and Instrumentation*, New Orleans, LA, American Meteorological Society, Boston, MA, J179-J181.

Womack, J. D. and T. L. Crawford, 1991: Description and demonstration of a continuous flow $\underline{\Delta}$ $pCO_2$ monitor. In *Proc. of the Conference on Meteorological Observations and Instrumentation*, New Orleans, LA, American Meteorological Society, Boston, MA, 34-36.

Crawford, T. L., R. T. McMillen and R. J. Dobosy, 1990: Development of a "generic" mobile flux platform with demonstration on a small airplane. NOAA Technical Memorandum ERL ARL-184, 81 pp.

Crawford, T. L. and G. Start, 1989: PFT sampler data management. Chapter 5. In: Across North America tracer experiment (ANATEX) volume I: description, ground level sampling at primary sites, and meteorology. NOAA Technical Memorandum ERL ARL-167.

Crawford, T. L., 1986: Measurements of two cloud events at Whitetop Mountain, Virginia. Presented at the APCA Second International Speciality Conference on Meteorology of Acid Deposition, March 1986, Albany, New York.

Crawford, T. L., 1984: Effect of regional emission reduction on regional sulfate levels. Presented at the Conference on Acid Rain Impact on Florida and the Southeast, April 1984, Orlando, Florida.

Parkhurst, W. J., T. L. Crawford, N. T. Lee and J. D. Lokey, 1984: The effect of a large-scale utility sulfur dioxide emissions control program on local and regional sulfur measurements. Presented at the 77th Annual Meeting of the APCA, June 24-29, 1984 San Francisco, California. Preprint No. 84-21.2.

Valente, R. J. and T. L. Crawford, 1983: Analysis and regulatory implications of visibility measurements for the Great Smoky Mountains National Park. Presented at the 76th Annual Meeting of APCA. Preprint No. 83-10P.6.

Crawford, T. L. and R. J. Valente, 1982: Visibility monitoring experience in the Great Smoky Mountains. Presented at the 75th Annual Meeting of the APCA, June 1982, New Orleans, Louisiana.

Crawford, T. L., S. F. Mueller and L. M. Reisinger, 1982: Air parcel tracking and trajectory analysis. Presented at the Third Joint Conference on Applications of Air Pollution Meteorology, January 12-15, 1982, San Antonio, Texas, 4 pp.

Crawford, T. L., L. M. Reisinger and S. F. Mueller, 1982: Analysis of differences between computed and observed tetroon trajectories. Presented at the APCA Specialty Conference on Acid Deposition, November 1982, Detroit, Michigan.

Reisinger, L. M. and T. L. Crawford, 1981: Interregional transport: case studies of measurements versus model predictions. Presented at the 77th Annual Meeting of the APCA, June 1981, Philadelphia, PA. Preprint No. 81-13.4.

Reisinger, L. M. and T. L. Crawford, 1980: Sulfur measurements - southern United States. Presented at the 73rd Annual Meeting of the APCA, June 1989, Montreal, Canada. Paper No. 80-40.6.

Crawford, T. L. and L. M. Reisinger, 1980: Transport and transformation of sulfur oxides through the Tennessee Valley region. EPA-600/7-80-126, 136 pp.

Reisinger, L. M. and T. L. Crawford, 1979: August 1976 sulfate episodes in the Tennessee Valley

region. Presented at the 72nd Annual Meeting of the APCA, June 24-29, 1979, Cincinnati, Ohio. TVA/EP 79/04, 19 pp.

Crawford, T. L., W. B. Norris and L. M. Reisinger, 1979: An analytical long-range transport model: development, analysis, and verification. Presented at and included in the Proc. of the 72nd Annual Meeting of the APCA, June 24-29, 1979, Cincinnati, Ohio. Preprint No. 79-29.4, 14 pp.

**Other Reports (Partial list)**

Crawford, T. L., 1974: The application of similarity theory to diffusion in the atmospheric surface layer. Presented at the Diffusion Workshop, March 1974, University of Waterloo, Waterloo, Canada.

Crawford, T. L., 1977: Atmospheric transport of radio nuclides. A summation of presented papers and subsequent discussion of the subject of the Working Group on Atmospheric Dispersion, Deposition, and Resuspension at a workshop in Gatlinburg, TN, September 6-9, 1977. DP-MS-77-116, 29 pp.

Crawford, T. L. and J. H. Coleman, 1978: Plume rise study at Johnsonville Steam Plant - data presentation. TVA/EP 78-05, 217 pp.

Crawford, T. L., L. M. Reisinger and J. H. Coleman, 1978: Project state - the Tennessee plume study V. TVA wind profile data. TVA/EP 78-16, 298 pp.

Coleman, J. H., T. L. Crawford and R. M. Rubendall, 1978: Characterization of the cooling tower plums from Paradise Steam Plant based on daily observations made in 1976. TVA Report I-AQ-77-6, 32 pp.

Meagher, J. F., T. L. Crawford and L. M. Reisinger, 1978: Project state - the Tennessee plume study I. TVA meteorological tower data. TVA Report I-AQ-78-12, 168 pp.

Reisinger, L. M., T. L. Crawford and J. F. Meagher, 1978: Project state - the Tennessee plume study III. Airmass trajectory data. TVA Report I-AQ-78-14, 35 pp.

Reisinger, L. M., T. L. Crawford and J. F. Meagher, 1978: Project state - the Tennessee plume study IV. TVA temperature profile data. TVA Report I-AQ-78-15, 163 pp.

Crawford, T. L. and J. H. Coleman, 1979: Plume rise study at Colbert Steam Plant - data presentation. TVA Report TVA/ONR-79/06, 72 pp.

Crawford, T. L. and J. H. Coleman, 1979: Plume rise study at Gallatin and Allen Steam Plants - data presentation. TVA Report TVA/ONR-79/07, 92 pp.

Crawford, T. L. and J. H. Coleman, 1979: Plume rise study at Shawnee Steam Plant - data presentation. TVA Report TVA/ONR-79/05, 150 pp.

Meagher, J. F. and T. L. Crawford, 1979: Transport and transformation of emissions from coal-fired power plants: the Tennessee Valley Authority research program. March 1979, 19 pp.

Parkhurst, W. J., T. L. Crawford and L. M. Reisinger, 1979: High-volume sampling: analysis of field variability and development of an improved suspended sulfate extraction technique. Tennessee Valley Authority, Muscle Shoals, Alabama.

Cope, D., T. L. Crawford and J. H. Coleman, 1980: Mathematical models for describing the atmospheric diffusion of sulfur dioxide and sulfate. TVA Report TVA/ARP-I80/30, 43 pp.

Crawford, T. L., 1983: Emission inventory adequacy for acid rain research. Presented at the Workshop on Acid Rain, May 2-3, 1983, Lexington, Kentucky, 12 pp.

Crawford, T. L., 1985: Visibility and other air quality measurements made at the Great Smoky Mountains National Park 1980-1983. Presented at the Uplands Annual Research Meeting, May 1985, Gatlinburg, Tennessee.

Crawford, T. L., 1985: Acidic inputs to high altitude forests. Presented at the National Acid Precipitation Assessment Program, September 1985, Boulder, Colorado.

Crawford, T. L. and L. M. Reisinger, 1985: Intensive monitoring of deposition and cloud interception at Whitetop Mountain, Virginia. Presented at the Second Annual Acid Rain Conference for the Southern Appalachians, October 1985.

Crawford, T. L., R. T. McMillen and J. A. Herwehe, 1991: Airborne and tower-based flux measurements during ROSE. Presented at the 1991 Fall AGU meeting, Dec. 9-13, 1991, San Francisco, CA, *EOS*, Transactions, American Geophysical Union, Vol. 72, No. 44, pp. 87, A31A-6.

Herwehe, J. A. and T. L. Crawford, 1991: The temporal and spatial distribution of ozone above a pine forest during ROSE. In *EOS*, Transactions, American Geophysical Union, Vol. 72, No. 44, pp. 87, A31A-5.

Dobosy, R. J., T. L. Crawford, and R. T. McMillen, 1992: Simpler wind measurements from moving vehicles using the global positioning system (GPS). Presented at the 72nd American Meteorological Society Annual Meeting, Third Symposium on Global Change Studies, Jan 5-10, 1992, Atlanta, GA, 118-121.

Crawford, T. L., R. J. Dobosy, D. D. Baldocchi and R. T. McMillen, 1993: Heat, momentum, and moisture flux from an airplane: comparison to tower measurements. Presented at and to be included in the Proceedings of the 73rd American Meteorological Society Annual Meeting and the Fourth Symposium on Global Change Studies, January 17-22, 1993, Anaheim, CA.

Daida, J. M., J. F. Vesecky, P. B. Russell, and T. L. Crawford, 1993. A remote sensing aircraft vehicle system for flux measurement over forest canopies. *In Proc. of the IEEE Topical Symposium on Combined Optical-Microwave Earth and Atmospheric Sensing,* 22-25 March, Albuquerque, New Mexico, 126-129.

Daida, J. M., P. B. Russell, T. L. Crawford and J. F. Vesecky, 1994. An unmanned aircraft vehicle system for boundary-layer flux measurement over forest canopies. Submitted, IEEE